SNAP PAC BRAINS USER'S GUIDE

SNAP-PAC-EB1
SNAP-PAC-EB2

Form 1690-070223—February 2007

OPTO 22

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SNAP PAC Brains User's Guide
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1: Introduction

About SNAP PAC Brains

SNAP PAC brains are powerful and versatile I/O and communications processors for your SNAP PAC System™. Designed primarily to work in distributed systems controlled by a SNAP PAC S-series or R-series controller, SNAP PAC brains provide local intelligence that frees the controller for supervisory tasks.

Two SNAP PAC brains are available: the **SNAP-PAC-EB1** and the **SNAP-PAC-EB2**. They are identical in their functions and features except that the SNAP-PAC-EB1 provides high-speed digital functions and analog ramping. The SNAP-PAC-EB2 does not offer high-speed digital functions or analog ramping. For a complete list of brain features, see page 16.

I/O Processing

As an I/O processor, the SNAP PAC brain provides the local intelligence to independently handle functions such as latching, counting, thermocouple linearization, watchdog timers, and PID loop control. These functions continue to work on the brain even if communication with the SNAP PAC controller is lost.

Each SNAP PAC brain mounts on a SNAP PAC rack with up to 4, 8, 12, or 16 SNAP I/O™ modules. Each module provides from 1 to 32 I/O points, depending on the module.

SNAP PAC brains support all the SNAP I/O analog, digital, serial, and special-purpose input and output modules available on the Opto 22 website. These modules can all be mixed on the same mounting rack and placed in any position on the rack, to accommodate the required mix of signals at any location.

For more information on mounting racks, see Opto 22 form #1684, the *SNAP PAC Racks Data Sheet*. For more information on I/O modules, visit our website at www.opto22.com.

Communications

In addition to I/O processing, SNAP PAC brains communicate over a standard 10/100 Mbps Ethernet network. Each SNAP PAC brain is equipped with two switched Ethernet network interfaces. Because these interfaces share a single IP address and act just like an Ethernet switch, SNAP PAC brains can be

installed in a multi-drop (daisy-chain) configuration, extending the control network without the expense of additional Ethernet network hardware. SNAP PAC brains can also be installed in a star configuration using standard, off-the-shelf Ethernet network components.

SNAP PAC brains support communication using multiple protocols running simultaneously over Ethernet. Most customers use the PAC Project software suite for control, monitoring, and data acquisition. At the same time, you can communicate using other methods.

PAC Project Software Suite

SNAP PAC brains are primarily designed for use with a SNAP PAC programmable automation controller. The controller runs a control program, called a *strategy*, which you develop using PAC Project™ software.

The PAC Project software suite comes in two forms, Basic and Professional:

- **PAC Project Basic**, which is included in the purchase of a SNAP PAC controller, consists of control programming, human-machine interface (HMI) creation, and configuration software.
- **PAC Project Professional** is available for purchase and adds OptoOPCServer™ for OPC communications, OptoDataLink™ for database connectivity, and additional features.

For more information about PAC Project, see form #1699, the *PAC Project Data Sheet*, available on our website, www.opto22.com.

Other Communication Methods

In addition to using a SNAP PAC controller with PAC Project software, you can communicate with SNAP PAC brains using Modbus®/TCP, SNMP for network management, FTP for the brain's built-in file system, SMTP (email client), and Opto 22's own memory-mapped OptoMMP protocol. Communication with OPC 2.0-compliant clients is available through OptoOPCServer.

- For **Modbus/TCP,** see Opto 22 form #1678, the *Modbus/TCP Protocol Guide*.
- For **SNMP**, **FTP**, and **SMTP**, see form #1704, the *PAC Manager User's Guide*.
- If you are not using PAC Project but want to develop custom software to communicate with the brain, the **OptoMMP** developer toolkit is available for free on our website, www.opto22.com. The OptoMMP Communication Toolkit includes ActiveX components and C++ classes, so you can use programming tools such as Visual Basic or Visual C++ to communicate with the brain. See form #1465, the *OptoMMP Protocol Guide*, for more information.
- For **OPC** connectivity, use OptoOPCServer, available either as part of PAC Project Professional or for separate purchase. See our website for more information.

About this Guide

This guide shows you how to install and use SNAP PAC brains. This guide assumes that you have some familiarity with TCP/IP and Ethernet networking. If you are not familiar with these subjects, we strongly suggest you consult commercially available resources to learn about them before attempting to install or use SNAP PAC brains.

The following sections are included in this user's guide:

Chapter 1: Introduction—information about the guide and how to reach Opto 22 Product Support.

Chapter 2: Installing a SNAP PAC Brain—quick-start steps to get SNAP PAC brains up and running quickly.

Chapter 3: System Architecture—conceptual information on networking and communicating with SNAP PAC brains, and brain specifications.

Chapter 4: Maintenance and Troubleshooting—changing IP addresses, resetting the brain to factory defaults, and upgrading firmware; blink codes and other troubleshooting assistance.

Other Documents You May Need

See the following additional guides for the information listed. All guides are available on the Opto 22 website, www.opto22.com; some are included on the CD that came with the SNAP PAC brain.

For this information	See this guide	Form #
Assigning IP address, loading new firmware, etc.	*PAC Manager User's Guide*	1704
Designing flowchart-based control programs for the system (requires a SNAP PAC S-series or R-series industrial controller)	*PAC Control User's Guide*	1700
	PAC Control Command Reference	1701
	PAC Control Commands Quick Reference Card	1703
Communicating with SNAP PAC brains using OPC	*OptoOPCServer User's Guide*	1439
Connecting the SNAP PAC System with databases	*OptoDataLink User's Guide*	1705
Communicating with SNAP PAC brains using Modbus/TCP	*Modbus/TCP Protocol Guide*	1678
Programming your own applications for SNAP PAC brains using the OptoMMP Communication Toolkit or the OptoMMP memory-mapped protocol	*OptoMMP Protocol Guide*	1465

For Help

If you have problems installing or using SNAP PAC brains and cannot find the help you need in this guide or on our website, contact Opto 22 Product Support.

Phone:	800-TEK-OPTO (835-6786) 951-695-3080 (Hours are Monday through Friday, 7 a.m. to 5 p.m. Pacific Time)
Fax:	951-695-3017
Email:	support@opto22.com
Opto 22 website:	www.opto22.com

NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.

When calling for technical support, be prepared to provide the following information about your system to the Product Support engineer:

- Software and version being used
- Brain and controller firmware version (as applicable)
- PC configuration (type of processor, speed, memory, and operating system)
- A complete description of your hardware and operating systems, including:
  - loader and firmware versions for the brain, and date code (available through PAC Manager; see page 24.)
  - IP addresses and net masks for devices on the system
  - type of power supply
  - third-party devices installed (for example, barcode readers)
- Specific error messages seen

2: Installing a SNAP PAC Brain

If you already know how you will use the SNAP PAC brain and want to get it running quickly, follow the sections in this chapter.

To learn about communication options and networking, start on page 9. Specifications are listed on page 15.

What You Will Need

You'll need the following items to install a SNAP PAC brain:

- PC running Microsoft® Windows® 2000 or higher, with a 10/100 MB Ethernet adapter card, the TCP/IP protocol installed, and a valid IP address, on the same subnet as the brain. (For more information, see "Networking" on page 13.)
- Standard Ethernet cable for direct connection to the PC, or an available connection to a standard 10BASE-T or 100BASE-TX Ethernet network.
- SNAP PAC brain (See page 16 for a chart comparing models.)
- SNAP PAC mounting rack and SNAP I/O modules chosen for your application.
- A SNAP-PS5 or SNAP-PS5U power supply or other 5 VDC power supply (-0/+0.1 VDC at 4.0 A) applied to the rack. (Additional power may be required for SNAP I/O modules depending on the number and type of modules used. See the module data sheets on our website, www.opto22.com, for information.)

Installing Software

In your CD-ROM drive, insert the CD that came with the brain. The installation wizard should start automatically. If it doesn't, use Windows Explorer to navigate to your CD-ROM drive and then double-click setup.exe. Follow directions to install the software.

Installing Hardware

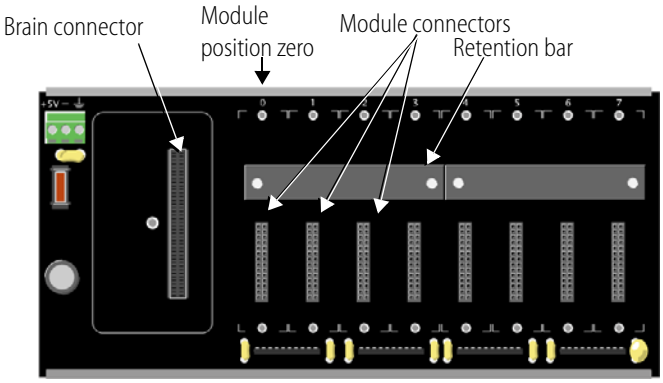
Assemble the rack and power supply according to the directions that came with them.

Installing Modules on the Rack

Modules snap into place in the row of connectors on the rack. Each module connector has a number.

NOTE: Any type of module can be placed in any position on the rack. Check module data sheets for power requirements and any quantity limitations.

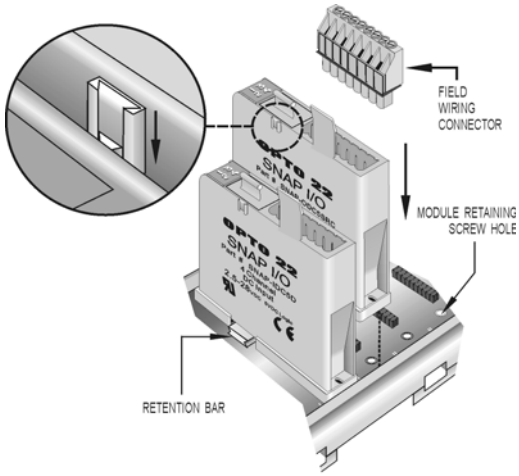
1. Place the rack so that the module connector numbers are right-side up, with zero on the left.



2. Position the module over the module connector, aligning the small slot at the base of the module with the retention bar on the rack.
3. With the module correctly aligned over the connector, push on the module to snap it into place.

   When positioning modules next to each other, be sure to align the male and female module keys (shown in the detailed view in the illustration at right) before snapping a module into position.

   Modules snap securely into place and require a special tool (provided) to remove them. To remove a module, see page 7.



4. (Optional) As shown in the photo at right, use standard 4-40 x 1/2 truss-head Phillips hold-down screws to secure both sides of each module.

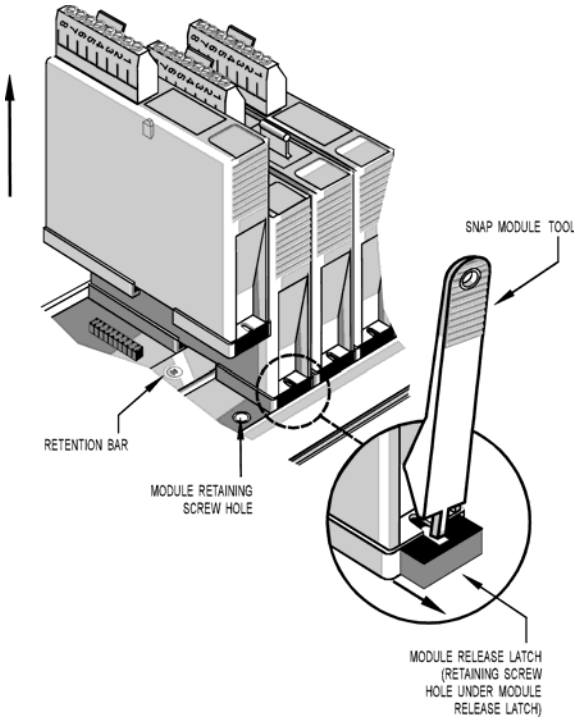
   CAUTION: *Do not over-tighten screws.*

5. Plug the wiring connector into each module to attach modules to the devices they monitor.

   Wiring diagrams are in the module's data sheet.

Removing a Module

1. If the modules are held in place with screws, remove them.
2. Holding the SNAP module tool (provided) as shown in the illustration at right, insert it into the notch at the base of the module.
3. Squeeze the module tool against the module to open the release latch, and pull straight up on the module to remove it.
4. Continue with "Installing the Brain" on page 8.


SNAP MODULE TOOL
RETENTION BAR
MODULE RETAINING SCREW HOLE
MODULE RELEASE LATCH (RETAINING SCREW HOLE UNDER MODULE RELEASE LATCH)

Installing the Brain

1. Remove the brain from its packaging.
2. Turn off power to the rack assembly.
3. Align the brain connector with the mating connector on the mounting rack.
4. Seat the brain onto the connector and use the hold-down screw to secure the brain in position. Do not overtighten.
5. Using Category 5 or superior solid unshielded twisted-pair cable, connect the brain in one of the following ways:
   - (Recommended for initial configuration) Connect to a PC directly, using a standard Ethernet cable.
   - Connect to a standard 10BASE-T or 100BASE-TX Ethernet network that has a PC on the same subnet as the brain and does NOT have a Dynamic Host Configuration Protocol (DHCP) server.

   Maximum cable or segment length is 100 meters; minimum cable length is one meter.
6. **Before** turning on power to the rack, follow instructions in Opto 22 form #1704, the *PAC Manager User's Guide*, to assign an IP address to the brain.

   This guide is in Adobe Acrobat PDF format on the CD that came with the brain and is also available from our website, www.opto22.com.

What's Next?

To start configuring I/O points, see instructions the *PAC Control User's Guide*, form #1700. (If you are not using PAC Control, follow configuration steps in the *PAC Manager User's Guide*.)

To learn more about SNAP PAC brain capabilities and network options, see Chapter 3: System Architecture.

To use OLE for process control (OPC) with SNAP PAC brains, purchase the OptoOPCServer and see Opto 22 form #1439, the *OptoOPCServer User's Guide*.

To communicate with SNAP PAC brains using Modbus/TCP, see form #1678, the *Modbus/TCP Protocol Guide*.

To program your own applications to communicate with the SNAP PAC brain, see Opto 22 form #1465, the *OptoMMP Protocol Guide*.

3: System Architecture

This chapter explains how to use SNAP PAC brains in an Ethernet network and how to communicate with them. It includes information on:

Communication options	See below
System architecture	See page 12
Networking	See page 13
Specifications and feature comparison charts	See page 15

Communication Options

SNAP PAC brains communicate using TCP/IP or UDP/IP over a wired or wireless network.

Physical Layer—SNAP PAC brains communicate over a 10- or 100-Mbps wired Ethernet link.

Transport Layer—The key to the SNAP PAC brain's communication flexibility is the transport layer, Internet Protocol (IP). Both the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP) are used with IP.

Application Layer—Because SNAP PAC brains use standard IP for the transport layer, many communication options are possible in the application layer. After the I/O unit is installed and has an IP address assigned (see page 8), you can communicate with it using the following methods:

- **PAC Control** strategies running on a SNAP PAC controller can configure, read, and write to I/O points on SNAP PAC brains.
- **PAC Manager** software, in addition to its use for assigning IP addresses, can also be used to configure I/O points and features, and perform onetime reads and writes.
- **Modbus/TCP** provides a direct connection with Modbus/TCP hardware or software or third-party software applications, which can read or write to I/O points on SNAP PAC brains.
- **OPC** (OLE for Process Control) uses OptoOPCServer to serve data to any OPC 2.0-compliant application, such as an HMI, which can also read or write to I/O points. OptoOPCServer can be purchased separately or as part of the PAC Project Professional software suite.

- **OptoDataLink** exchanges I/O point data with ODBC-compliant databases, including Microsoft SQL Server, Microsoft Access, MySQL, and others. OptoDataLink can be purchased separately or as part of PAC Project Professional.
- **SMTP** (Simple Mail Transfer Protocol) connects a SNAP PAC brain with corporate email servers, so employees can be emailed or paged if there's a problem on devices attached to the brain.
- **SNMP** (Simple Network Management Protocol) makes it possible to monitor devices attached to SNAP PAC brains just as you would any computer or server on the Ethernet network, using an SNMP-based enterprise management system such as Computer Associates' Unicenter®, Hewlett-Packard's OpenView®, or IBM's Tivoli®. When a monitored event occurs, such as a door left open or a pressure level too high, the brain sends an SNMP trap to the management system.
- **FTP** (File Transfer Protocol) can be used to transfer files and data to and from the SNAP PAC brain, whether to custom applications, enterprise databases, or any file system.
- **Custom software applications** are easy to develop using our OptoMMP Communication Toolkit with ActiveX components and C++ classes. They use the OptoMMP protocol, an IEEE 1394-based protocol, to read and write to SNAP PAC brains. For developers not using Microsoft Windows, our OptoMMP protocol is open and documented.

Simultaneous Communication

In addition to communicating using all the methods listed above, each SNAP PAC brain can also communicate *simultaneously* using all of these methods.

The reason lies in the nature of IP. In serial communication, a single data request is sent by one device to another. The first device must wait for a response before any additional communication can be carried out. IP, however, can establish multiple simultaneous sessions, so many data requests can be sent at once without waiting for any individual response. Each request gets a response, but the link isn't idle while waiting for responses.

In addition, IP can simultaneously handle multiple requests from multiple devices. A PC can communicate with all SNAP PAC brains and controllers on the same network—all at the same time—and multiple PCs can communicate with one SNAP PAC device at the same time.

So, for example, a SNAP PAC brain can respond to directions from a Modbus master, give analog point data to a technician using PAC Manager, and carry out instructions from a custom C++ application—all at once.

Accessing SNAP PAC Brains Over the Internet

Since SNAP PAC brains are just like any other hardware on the Ethernet network, you can access them over the Internet in exactly the same way you would access a computer. The details depend on your network and Internet connection. Consult your system or network administrator or your Internet Service Provider (ISP) for more information.

Choosing Communication Methods

How do you need to communicate with SNAP PAC brains to match the tasks your application requires? Check the following table for help in choosing communication methods and finding out where to look for more information on them.

This task	Can be done using these methods		Comments and references
	Recommended	Alternate	
Configure I/O units.	PAC Control (I/O points only) or PAC Manager (I/O points and other functions)	OptoMMP Communication Toolkit or OptoMMP protocol	If you are using PAC Control, configure the system in PAC Control. See the *PAC Control User's Guide*. For the Communication Toolkit or OptoMMP protocol, see *OptoMMP Protocol Guide*.
Monitor and control processes; acquire data.	PAC Control flowchart logic	PAC Manager Inspect window or OptoMMP Communication Toolkit or OptoMMP protocol	See *PAC Control User's Guide* & *Command Reference*. CAUTION! Events and reactions set up using alternate methods are faster than flowchart logic, but be careful if you use them. They can conflict with PAC Control logic, because both write to the brain's memory map. For Communication Toolkit or OptoMMP protocol, see *OptoMMP Protocol Guide*.
Give technicians an Opto 22 HMI with alarming and trending.	PAC Display		See *PAC Display User's Guide.*
Communicate with Modbus/TCP hardware or software.	Modbus/TCP		See *Modbus/TCP Protocol Guide*.
Exchange I/O point data with third-party software such as HMIs and databases.	OptoOPCServer for OPC; OptoDataLink for databases		Purchase OptoOPCServer or OptoDataLink separately or as part of PAC Project Professional. See *OptoOPCServer User's Guide* and *OptoDataLink User's Guide*.
Send email or page someone. Send SNMP trap. Monitor devices through an enterprise management system.	PAC Control (and PAC Manager for configuration)	OptoMMP Communication Toolkit or OptoMMP protocol	If you are using PAC Control, configure email using PAC Manager. See the *PAC Manager User's Guide*. For Communication Toolkit or OptoMMP, see *OptoMMP Protocol Guide*.
Write your own software application to communicate with the system.	C++ or Active X: OptoMMP Communication Toolkit and brain's memory map.	Opto 22's OptoMMP protocol and brain's memory map.	See *OptoMMP Protocol Guide.*

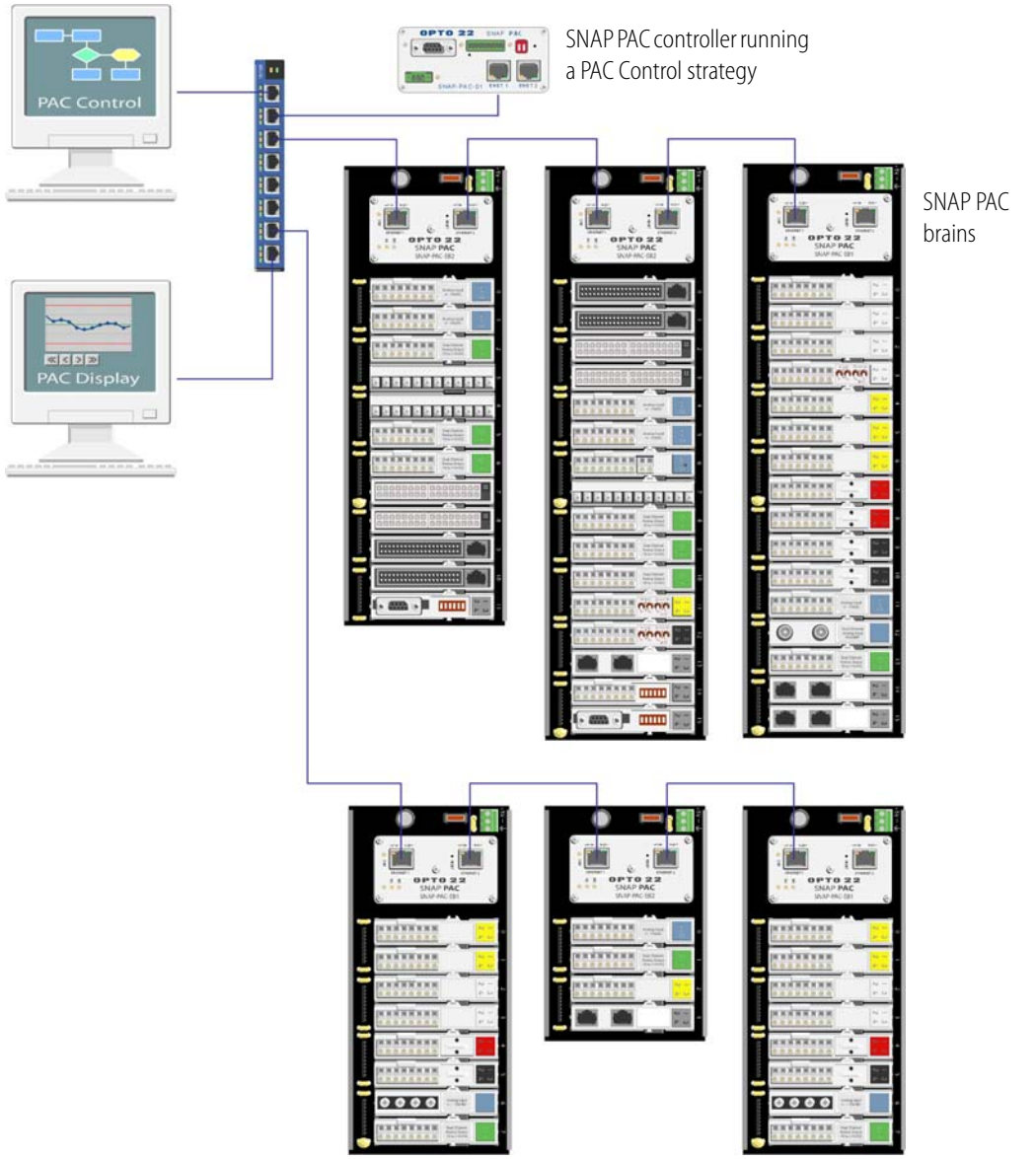
System Architecture

SNAP PAC brains can be used in two ways:

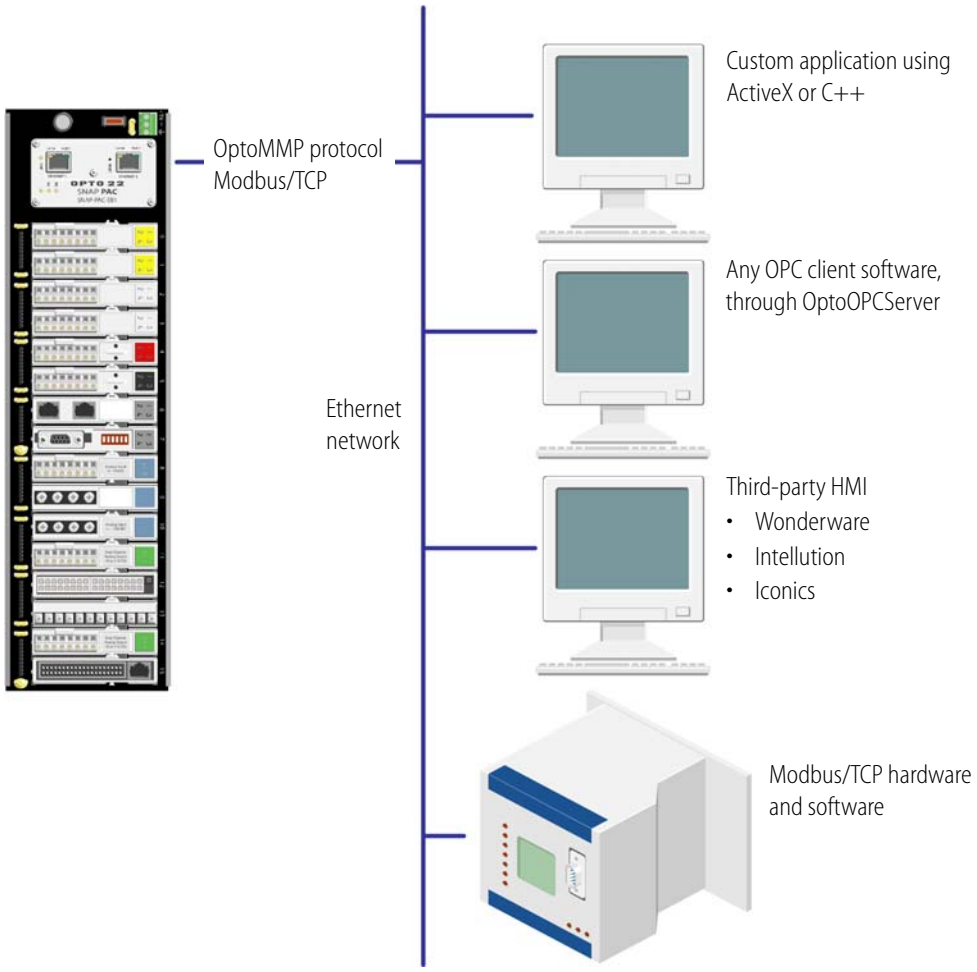
- For distributed intelligence in a larger control system based on a SNAP PAC controller running PAC Control
- As an independent I/O processor. You can communicate with an independent SNAP PAC brain using Modbus/TCP, the OptoOPCServer (available separately), SNMP, SMTP, or applications you develop using the free OptoMMP Communication Toolkit or our OptoMMP protocol.

The following diagrams illustrate these two uses.

SNAP PAC Brains as Part of a Distributed SNAP PAC System



SNAP PAC Brain as an Independent I/O Processor



Networking

From a physical standpoint, SNAP PAC brains can be networked in several ways:

- Connected directly to a PC or controller using a standard Ethernet cable
- Attached to an existing TCP/IP Ethernet network
- As part of an independent network built with standard Ethernet hardware

The networking method you use depends on several things, including whether you need control or data acquisition, the number of PCs and I/O units you are using, the speed and volume of communication, security requirements, and the availability of an Ethernet network.

Connecting the Brain Directly to a PC or Controller

A direct connection using a standard Ethernet cable connects the SNAP PAC brain with one host, either a PC or a controller. (A crossover cable is not required for direct connection to a host.)

Additional SNAP PAC brains can be daisy-chained (multi-dropped) from the first brain using the brain's second Ethernet network interface, which acts as a network switch.

If you need only a small control or monitoring network and have no existing Ethernet network, a direct connection is ideal. It's quick, easy, and inexpensive because it requires only cables (no separate Ethernet switches or routers). It also provides high speed and high security for a small system.

A direct connection is also useful for assigning an IP address, configuring I/O points, and testing applications. The direct connection eliminates other variables that could interfere with communication, so you can focus on maintenance and troubleshooting.

NOTE: If you use a multi-drop configuration for your SNAP PAC brains, be aware that if a brain loses power, communication to all brains beyond it on the daisy chain will also be lost.

Attaching the Brain to an Existing Ethernet Network

The first rule in attaching SNAP PAC brains to an existing network is to work closely with your system administrator, who must determine network topology and hardware. Be sure to consider the impact on your existing network of adding the brains. For best performance, use a 100 Mbps network.

In addition, make sure the system administrator understands that each brain must have a **fixed (static)** IP address, whether or not a Dynamic Host Configuration Protocol (DHCP) server is used on the network. For more information on IP addresses, see the *PAC Manager User's Guide*.

If you need to isolate the control system data from the main network backbone, you can use a router, network switch, or other gateway device. You can also use a SNAP PAC S-series controller, which has two independent Ethernet network interfaces: one interface can be connected to the enterprise network, and the other used for the control system. (For more information, see the SNAP PAC S-Series data sheet, form #1584).

Using the Brain in an Independent Network

The third way SNAP PAC brains can be used is by developing an independent network. An independent network gives a high level of communication speed and volume, as well as high security. You may also need a separate network for critical control applications. Again, the choice depends on your requirements for data transactions, data security, and whether a near-deterministic system is necessary.

If you are building your own network, remember that each brain must have a **fixed** IP address. See the *PAC Manager User's Guide* for more information on IP addresses.

If you have no existing Ethernet network, you can use off-the-shelf Ethernet components to build one. Because the SNAP PAC brain has a built-in Ethernet switch, you can daisy-chain brains together in a multi-drop configuration. Or you can purchase standard Ethernet switches to install brains in a star configuration. If you use a multi-drop configuration for your SNAP PAC brains, remember that if a brain loses power, communication to all brains beyond it on the daisy chain will also be lost.

Since Ethernet and TCP/IP are worldwide standards, there are a number of commercially available resources for learning about building and maintaining such a network. We strongly suggest you learn as much as possible about the subject and plan your network carefully before beginning, in order to get the best performance from your system.

Specifications

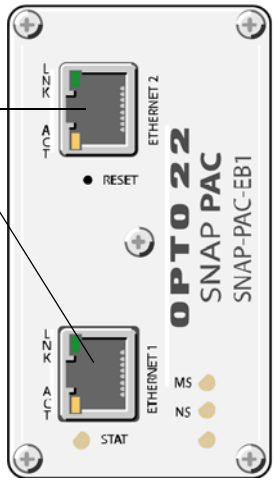
Specifications:

Power Requirements	5.0–5.2 VDC at 750 mA maximum (does not include module power requirements)
Memory	16 MB RAM
Backup battery	CR2032 Lithium, user replaceable. 10-year minimum life for real-time clock backup.
Network Interfaces	IEEE 802.3 network, 10Base-T and 100Base-TX. Automatic MDC/MDI-X crossover (Ethernet crossover cable not required for direct connection to PC). Two switched ports, allowing multi-drop (daisy-chain) or standard star network configuration.
Maximum Ethernet Segment Length	100 meters with Category 5 or superior UTP. For 100 Mbps at this distance, use Category 5 or superior solid UTP.
Operating Tempera-ture	0 to 70 °C
Storage Temperature	-40 to 85 °C
Humidity	0–95% humidity, non-condensing

LEDs and Network Interfaces

Switched Ethernet network interfaces
Brains can be networked in a multi-drop (daisy-chain) configuration or in a standard star configuration using either Ethernet interface. Both interfaces use the same IP address.

NOTE: When using a multi-drop configuration, be aware that if power to a brain is lost, all brains beyond it on the network will also lose communication.



LEDs

LED	Indicates
LNK	Link established with Ethernet network
ACT	Activity on Ethernet network
STAT	Brain status
MS NS Unnamed	Reserved for future use

SNAP PAC Brain Comparison Chart

For descriptions of features, see page 17. The following table compares SNAP PAC brains with firmware 8.0.

FEATURE		SNAP-PAC-EB1	SNAP-PAC-EB2
I/O modules supported	Digital (4–32 channels)	●	●
	Analog (2–32 channels)	●	●
	Serial (RS-232, RS-485)	●	●
	Special-purpose (motion control, power monitoring, Profibus®, Wiegand®)	●	●
Digital I/O point features	On/off status	●	●
	Input latching	●	●
	Watchdog timer[1]	●	●
	High-speed counting (up to 20 kHz)[1]	●	
	Quadrature counting[2]	●	
	On-pulse and off-pulse measurement[1,3]	●	
	TPO (time-proportional output)[3]	●	
	Pulse generation (N pulses, continuous square wave, on-pulse, and off-pulse)[3]	●	
Analog I/O point features	Thermocouple linearization (32-bit floating point for linearized values)	●	●
	Minimum/maximum values	●	●
	Offset and gain	●	●
	Scaling	●	●
	Time-proportional output[4]	●	●
	Output clamping	●	●
	Filter weight	●	●
	Watchdog timer	●	●
	Ramping[3]	●	
Ethernet networking		●	●
Two switched Ethernet network interfaces (one IP address)		●	●
Maximum number of modules allowed per I/O unit (with largest rack): Any mix of 16 digital, 16 analog, 8 serial or special-purpose		●	●
PID logic on the brain (96 PID loops per brain)		●	●
Modbus®/TCP		●	●
OPC driver support		●	●
OptoMMP memory-mapped protocol		●	●

FEATURE	SNAP-PAC-EB1	SNAP-PAC-EB2
SNMP (network management)[5]	●	●
FTP server, file system	●	●
Email (SMTP client)	●	●
Scratch Pad area for peer-to-peer data (bits, floats, integers, and strings)	●	●
Digital events[1], Alarm events, Serial events, and Timed events[1]	●	●
Event messaging	●	●
UDP Streaming	●	●
Data logging in the brain	●	●
Security (IP filtering, port access)	●	●
Realtime clock (RTC)	●	●
I/O point data mirroring and memory map copying	●	●

1 Four-channel digital modules only; not available on high-density digital modules.
2 Requires a SNAP quadrature input module (SNAP-IDC5Q).
3 Available when used with PAC Control Professional and a SNAP PAC controller.
4 Requires a SNAP analog TPO module (SNAP-AOD-29).
5 Currently not available on analog modules with more than 4 points.

Feature Descriptions

See the feature table on page 16. For additional information, including configuration, see the *PAC Manager User's Guide*.

Feature	Description
States	(Digital input and output)—A digital point is either on or off. You can read the current state of a digital input or write an on/off state to a digital output.
Latches	(Digital input)—When the value of a digital input point changes from off to on, an on-latch is automatically set. While the value of the point may return to off, the on-latch remains set, as a record of the change, until you clear it. Similarly, an off-latch is set when the value of a digital point changes from on to off, and it remains set until cleared.
Counters	(Digital input)—A counter keeps track of the number of times a digital input changes from off to on. The count accumulates until it reaches the maximum count available in the brain or until you reset the counter to zero. For example, to count the number of widgets produced per shift, you would clear the counter at the start of each shift and read it at the end of each shift. SNAP-PAC-EB1 brains offer high-speed counting (up to 20 KHz) on 4-channel modules; the speed of the counter depends upon the speed of the module used. Both brains offer low-speed counting (about 50 Hz) on high-density modules; counting is done in the module.
Quadrature counters	(Digital input)—A quadrature counter requires a SNAP quadrature input module, which is attached to the encoder device. The module sends a pulse to the brain upon each change in quadrature state, and the brain counts the pulses and keeps track of the direction and rotation.

Feature	Description
Time-proportional output (TPO)	Time-proportional output varies the duty cycle and the percentage of on time within that cycle. TPO is often combined with a PID loop and used to control the output, for example in a heater or oven. (Digital output)—Supported by SNAP-PAC-EB1 only; requires PAC Project Pro and a SNAP PAC controller. (Analog output)—Both SNAP PAC brains support analog TPO using a SNAP-AOD-29 module.
On-pulse and off-pulse measurement	(Digital input; requires SNAP-PAC-EB1, PAC Project Pro, and a SNAP PAC controller)—A pulse is a brief on (or off) state, usually repeated at a specific interval. The brain can measure the first pulse, that is, the amount of time the input stays on (or stays off).
Pulse and square wave generation	(Digital output; requires SNAP-PAC-EB1, PAC Project Pro and a SNAP PAC controller)—A pulse turns a digital output on (or off) briefly, either once or for a specified number of times at a specified interval. A digital square wave is a specific pattern of on and off states, repeated continuously.
Watchdog	(Digital and analog input and output)—A watchdog monitors communication with the PC or other host device. If the host does not write data to the I/O unit for the length of time set in the watchdog, the I/O unit automatically sets designated digital and analog output points to the values you have determined. If communication fails between the host and the brain controlling a process, a watchdog makes sure the process is automatically brought to a safe state. For example, a valve could automatically close to avoid completely emptying a tank.
Scaling	(Analog input and output)—Analog input and output points can be scaled as needed. For example, you can scale a -5 V to +5 V input point to reflect 0% to 100%
Minimum and maximum values	(Analog input)—Minimum and maximum values are sometimes called peaks and valleys. You can read these values at any time, for example, to record minimum and maximum temperatures. You can also reset min/max values. For example, if you want to record the maximum temperature at point 2 in each 24-hour period, you must reset the values after they are read each day.
Thermocouple linearization	(Analog input)—The brain automatically converts the thermocouple junction's millivolt values into temperature values, so you don't have to. Choose the appropriate module and make sure you configure the point as the correct thermocouple type (E, K, etc.) for your purpose.
Offset and gain	(Analog input)—Offset and gain calculations are used to calibrate analog points. If a -50 mV to +50 mV input receives signals that are slightly off (not exactly -50 mV at the lowest point, for example), the offset and gain can be calculated so that values will appear accurately when read.
Clamping	(Analog output)—Clamping limits values that can be sent to analog output points so they do not go above or below a specific value. For example, if you are using a 0–10 VDC output module, but the device attached to one of its points can only handle a maximum of 5 VDC, you can set an upper clamp of 5 VDC for that point. The values for upper and lower clamp are set in engineering units.
Ramping	(Analog output; requires SNAP-PAC-EB1, PAC Project Pro, and a SNAP PAC controller)—Some devices attached to analog outputs should not be abruptly stepped up or down, because a sudden change might damage the equipment or cause other problems. Instead, you can gradually ramp the device up or down to the desired value.
PID loop control	(Analog points)—Proportional integral derivative (PID) loops are used to drive an input toward a particular value (the setpoint) and keep the input very close to that value by controlling an output. PID loops are often used in temperature control.
Average filter weight	(Analog inputs)—A filter weight smooths analog input signals that are erratic or change suddenly. See the *PAC Manager User's Guide* for more details.

Feature	Description
Events, Timers, Event Messages, Email, Data Logging, Data Mirroring, and Memory Map Copying	You can configure a SNAP PAC brain to recognize one or a combination of the following as an event: • The state of a point on a 4-channel digital module (on or off) • A specific high or low value of an analog point, in Engineering Units • A number on a digital counter or a high or low number on a quadrature counter • An analog point value or a quadrature counter that is outside an allowable range • The state of a bit in the Scratch Pad (on or off) • A specific string received by a serial module. The brain can react automatically to an event in any or all of the following ways: • Turning points on 4-channel digital modules on or off (same or different brain) • Copying data from one memory map location to another (same or different brain) • Logging data • Turning a bit in the Scratch Pad on or off • Sending a stream packet, an email message, or an SMNP trap • Sending a string through a serial module to a serial device You can also use a timer to set up a delay between the event and the reaction.
Security	You can limit access to SNAP PAC brains either by allowing access only from specific computers or other devices on the network (IP filtering), or by limiting access to specific protocols, such as SNMP, that are used with the brain (port access).
Scratch Pad Areas	The Scratch Pad is used primarily for peer-to-peer communication with other SNAP PAC brains and controllers on the network. See the *PAC Control User's Guide*.
SNMP	The Simple Network Management Protocol (SNMP) is used to communicate with an SNMP-based enterprise management system, such as Computer Associates' Unicenter, Hewlett-Packard's OpenView, or IBM's Tivoli. These systems can manage analog, digital, or serial devices through a SNAP PAC brain just as they manage computer equipment on the Ethernet network.
FTP Server	SNAP PAC brains have a substantial area available for file storage, and data can be easily moved to and from these files using FTP. For more information on the file system, see the *PAC Manager User's Guide*.

4: Maintenance and Troubleshooting

Introduction

This chapter includes the following maintenance and troubleshooting information:

Maintenance

Backup Battery	below
Changing the Brain's IP Address	page 22
Resetting the Brain	page 22
Loading New Firmware	page 22
Setting Time and Date	page 23
Blink Codes	page 23

Troubleshooting

Getting Device and Firmware Information	page 24
Communicating with the Brain	page 24
Additional Troubleshooting Tools	page 28

Maintaining the SNAP PAC Brain

Backup Battery

The real-time clock on the SNAP PAC brain uses a CR2032 lithium backup battery, which is user replaceable. These batteries are readily available in retail stores.

Changing the Brain's IP Address

If you know the SNAP PAC brain's IP address, see the *PAC Manager User's Guide* for instructions to change it.

If you do not know the IP address, first check the label on the side of the brain. If you still don't know the brain's IP address, follow the steps in the next section to restore the brain to factory default settings, and then assign an IP address as described in the *PAC Manager User's Guide*.

Resetting the Brain

1. Carefully insert a straightened paperclip or stiff wire into the small hole labeled RESET.
2. Press and hold down the RESET button as described below.

To perform this kind of reset...	...do this	Result
Simple restart	Press and hold the RESET button for less than 1 sec. until the STAT LED turns off, and then immediately release the button. OR Turn off power to the brain and then turn it on again. OR Use PAC Manager to send the brain the "Restart from Powerup" command.	• The brain restarts. • Any files in RAM are erased. If files have been stored to flash memory, they will not be erased.
Restore factory default settings	Press and hold the RESET button for 1 or 2 seconds until the STAT LED turns solid green, and then immediately release the button.	• The brain restarts. • Files in RAM and flash memory are erased. • IP address is reset to 0.0.0.0 and subnet mask to 255.255.255.0.

CAUTION: *If you hold down the RESET button longer than the time needed to restore the default settings, the brain will restart in fail-safe bootloader mode, which is indicated by the STAT LED blinking green 7 times quickly. This is a diagnostic mode that you don't need to access unless you are troubleshooting a problem with Opto 22 Product Support. If your brain restarts in fail-safe bootloader mode, simply cycle power to the device. This action performs the simple restart described above.*

Loading New Firmware

Each SNAP PAC brain contains firmware (sometimes referred to as the *kernel*), which is similar to an operating system. If the firmware should become damaged, or if a new version of the firmware is released, you can load new firmware to the brain following instructions in the *PAC Manager User's Guide*.

Setting Time and Date

The SNAP PAC brain's built-in clock is set at the factory. To change the time and date, see instructions in the *PAC Manager User's Guide*.

Blink Codes

The STAT LED on the top of a SNAP PAC brain uses blink codes to indicate status conditions. (See "LEDs and Network Interfaces" on page 15 for the location of the STAT LED.) The blink codes can be useful during operation and in troubleshooting.

If the STAT LED is on and remains green, the brain has an IP address and is operating normally.

If the STAT LED blinks orange about four times a second, the device is attempting to obtain an IP address by sending BootP requests.

If the STAT LED blinks green when the brain starts up, it indicates the following:

Number of Blinks	Speed of Blinks	Means
2	fast	Normal; the brain's firmware is starting up.
5	fast	Default settings have been successfully restored.
7	fast	Entering fail-safe bootloader mode. (See "Resetting the Brain" on page 22 for more information.)

If the STAT LED is blinking red, it indicates the following:

Number of Blinks	Speed of Blinks	Means	Problem and Workaround
4	slow	Invalid MAC address or hardware revision	Contact Product Support.
5	slow	Fatal error	Firmware or hardware problem. Check the power supply and connections before restarting. Call Product Support if the error is repeated.
6	slow	RAM error	Contact Product Support.
7	slow	Ethernet switch failure	Contact Product Support.
11	slow	Ethernet loopback test failure	Make sure an Ethernet cable is connecting the two network interfaces. If the error is repeated, contact Product Support.
13	slow	Real-time clock failure	Contact Product Support.
16	slow	Serial flash failure	Contact Product Support.
20	slow	Digital failure	Contact Product Support.
21	slow	Bus failure	Contact Product Support.

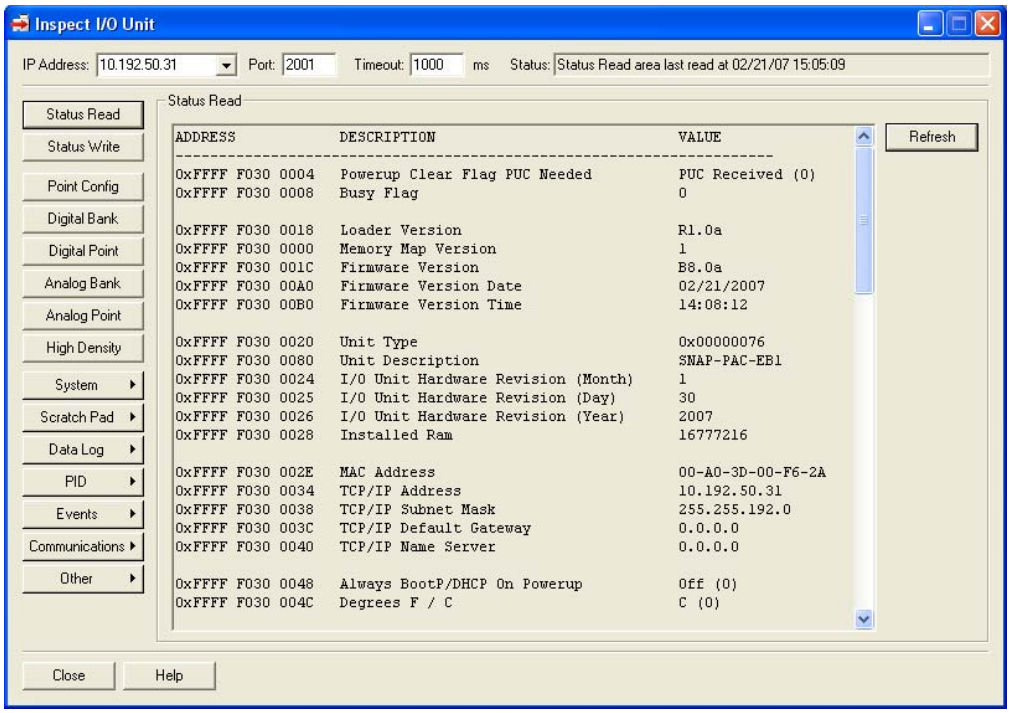
Troubleshooting the SNAP PAC Brain

If you encounter a problem while installing or using the SNAP PAC brain, check the information in this section. If you need to contact Opto 22 Product Support, see "For Help" on page 4.

Getting Device and Firmware Information

If you need to contact Opto 22 Product Support for assistance, it is helpful to have device and firmware information at hand before you call us.

1. Choose Start→Programs→Opto 22→PAC Project Software→PAC Manager.
2. In the PAC Manager main window, click the Inspect button .
3. In the IP Address field, type the IP address of the device. Click Status Read.


Inspect I/O Unit
IP Address: 10.192.50.31
Port: 2001
Timeout: 1000 ms
Status: Status Read area last read at 02/21/07 15:05:09
Status Read
Status Write
Point Config
Digital Bank
Digital Point
Analog Bank
Analog Point
High Density
System
Scratch Pad
Data Log
PID
Events
Communications
Other
Refresh
ADDRESS DESCRIPTION VALUE
0xFFFF F030 0004 Powerup Clear Flag PUC Needed PUC Received (0)
0xFFFF F030 0008 Busy Flag 0
0xFFFF F030 0018 Loader Version R1.0a
0xFFFF F030 0000 Memory Map Version 1
0xFFFF F030 001C Firmware Version B8.0a
0xFFFF F030 00A0 Firmware Version Date 02/21/2007
0xFFFF F030 00B0 Firmware Version Time 14:08:12
0xFFFF F030 0020 Unit Type 0x00000076
0xFFFF F030 0080 Unit Description SNAP-PAC-EB1
0xFFFF F030 0024 I/O Unit Hardware Revision (Month) 1
0xFFFF F030 0025 I/O Unit Hardware Revision (Day) 30
0xFFFF F030 0026 I/O Unit Hardware Revision (Year) 2007
0xFFFF F030 0028 Installed Ram 16777216
0xFFFF F030 002E MAC Address 00-A0-3D-00-F6-2A
0xFFFF F030 0034 TCP/IP Address 10.192.50.31
0xFFFF F030 0038 TCP/IP Subnet Mask 255.255.192.0
0xFFFF F030 003C TCP/IP Default Gateway 0.0.0.0
0xFFFF F030 0040 TCP/IP Name Server 0.0.0.0
0xFFFF F030 0048 Always BootP/DHCP On Powerup Off (0)
0xFFFF F030 004C Degrees F / C C (0)
Close
Help

Keep this window open on your screen when you call Product Support.

Communicating with the Brain

If you attempt to connect to the brain using its IP address and you cannot, first check the following:

- Make sure the brain has been turned on and the LNK and STAT LEDs for the connected Ethernet interfaces are lit (see "LEDs and Network Interfaces" on page 15.)
- Make sure the brain's hold-down screw has been tightened so that it is firmly attached to the rack. (Do not overtighten.)

- Verify that you typed in the correct address for the brain. Check the label on the side of the brain, where the IP address should be written.
- Make sure the brain has been assigned a valid IP address and subnet mask. SNAP PAC brains come from the factory with a default IP address of 0.0.0.0, which is invalid. The default subnet mask is 255.255.255.0. To assign an IP address and subnet mask, see the *PAC Manager User's Guide*.
- Make sure that no red LEDs on the brain are lit. A red LED could indicate a voltage supply problem. Each brain should have its own power supply. The brain needs a minimum of 5.0 VDC, measured at the rack.
- Make sure you have up-to-date drivers installed on your computer's Network Interface Card (NIC). Contact your system administrator or the manufacturer of the card for help.
- Make sure you have Administrator privileges on your computer and that any firewall in the computer (such as the built-in firewall in Windows XP) is temporarily disabled before you try to assign or change IP addresses, load firmware using PAC Manager's Maintenance window, or work with files on the brain. BootP and FTP cannot function through a firewall in the PC. Firewalls in a router are less likely to be a problem.

Pinging the Brain

If you still cannot communicate with the brain after you have checked these items, try to reach it using the PING protocol.

1. Choose Start→Programs→Accessories and open a command prompt window.
2. At the prompt, type: `ping [brain's IP address]`

   For example, type: `ping 10.192.54.40`

If the brain responds, go to "Accessing the Brain with PAC Manager" on page 25.

If the PING command cannot be found, choose Start→Control Panel→Network. Make sure TCP/IP is configured as a protocol and that an IP address and subnet mask are assigned.

If you see the message "Destination host route not defined," the brain probably has an inappropriate IP address and subnet mask. Make sure the IP address and subnet mask on the brain are compatible with those on the computer. Follow the directions beginning on page 22 to check the IP address and subnet mask on the brain, and change them if necessary.

If you see the message "No response from host," check the following:

- Are the computer and brain correctly connected? Is the brain turned on?
- Are the IP address and subnet mask on the brain compatible with those on the computer?
- Is the brain in reset mode? (Check for a blinking STAT LED. STAT blink codes are shown on page 23.)

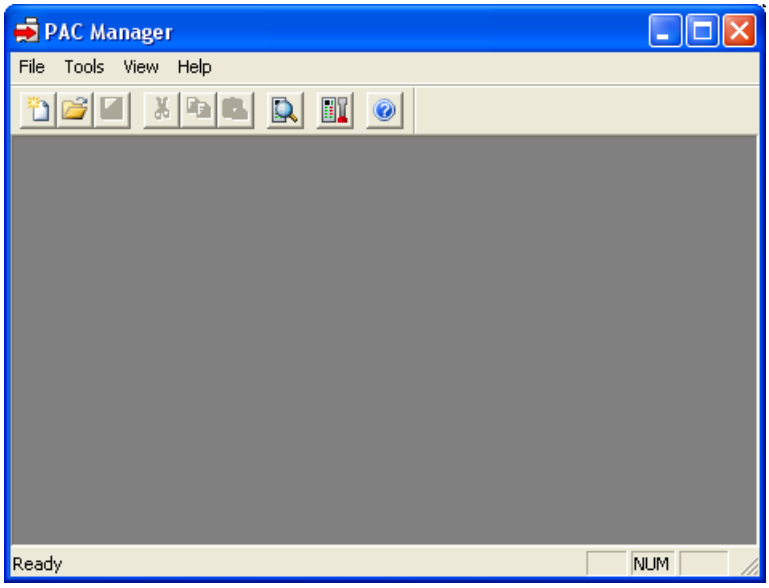
If you still cannot ping the brain, contact Opto 22 Product Support. (See page 4.)

Accessing the Brain with PAC Manager

Once you know you can ping the brain, try to access it using PAC Manager. You will need to know the brain's IP address.

1. If PAC Manager is not already open, choose Start→Programs→Opto 22→PAC Project→PAC Manager.

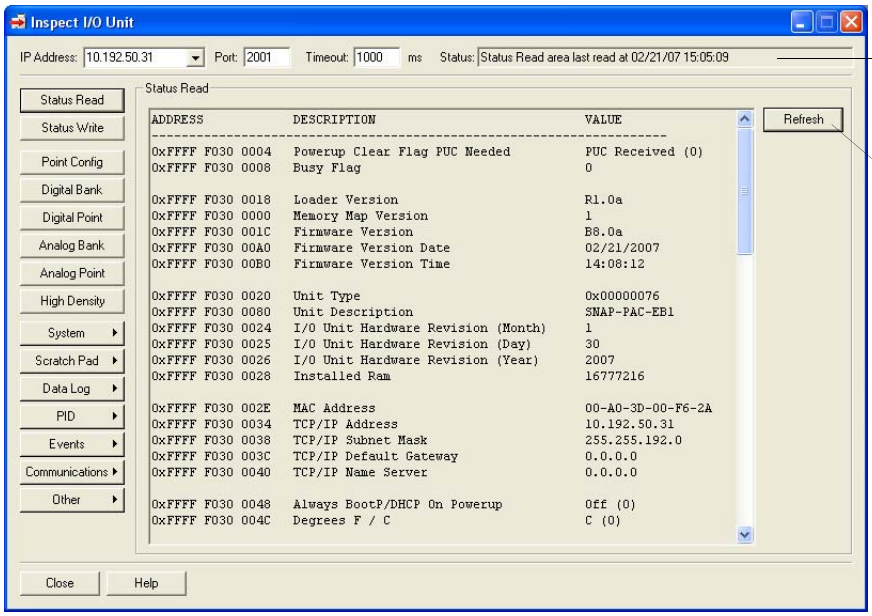
   The PAC Manager main window opens:



2. In the PAC Manager main window, click the Inspect button .

3. In the IP Address field, type the IP address of the brain (or choose it from the drop-down list). Click Status Read.

   Information from the brain is displayed in the window:


Inspect I/O Unit
IP Address: 10.192.50.31
Port: 2001
Timeout: 1000 ms
Status: Status Read area last read at 02/21/07 15:05:09
Status Read
Status Write
Point Config
Digital Bank
Digital Point
Analog Bank
Analog Point
High Density
System
Scratch Pad
Data Log
PID
Events
Communications
Other
Status Read
Refresh
ADDRESS DESCRIPTION VALUE
0xFFFF F030 0004 Powerup Clear Flag PUC Needed PUC Received (0)
0xFFFF F030 0008 Busy Flag 0
0xFFFF F030 0018 Loader Version R1.0a
0xFFFF F030 0000 Memory Map Version 1
0xFFFF F030 001C Firmware Version B8.0a
0xFFFF F030 00A0 Firmware Version Date 02/21/2007
0xFFFF F030 00B0 Firmware Version Time 14:08:12
0xFFFF F030 0020 Unit Type 0x00000076
0xFFFF F030 0080 Unit Description SNAP-PAC-EB1
0xFFFF F030 0024 I/O Unit Hardware Revision (Month) 1
0xFFFF F030 0025 I/O Unit Hardware Revision (Day) 30
0xFFFF F030 0026 I/O Unit Hardware Revision (Year) 2007
0xFFFF F030 0028 Installed Ram 16777216
0xFFFF F030 002E MAC Address 00-A0-3D-00-F6-2A
0xFFFF F030 0034 TCP/IP Address 10.192.50.31
0xFFFF F030 0038 TCP/IP Subnet Mask 255.255.192.0
0xFFFF F030 003C TCP/IP Default Gateway 0.0.0.0
0xFFFF F030 0040 TCP/IP Name Server 0.0.0.0
0xFFFF F030 0048 Always BootP/DHCP On Powerup Off (0)
0xFFFF F030 004C Degrees F / C C (0)
Close
Help
Date and time data was last read
Click to update data

If information does not appear, contact Product Support. (See page 4.)

Solving Network Problems

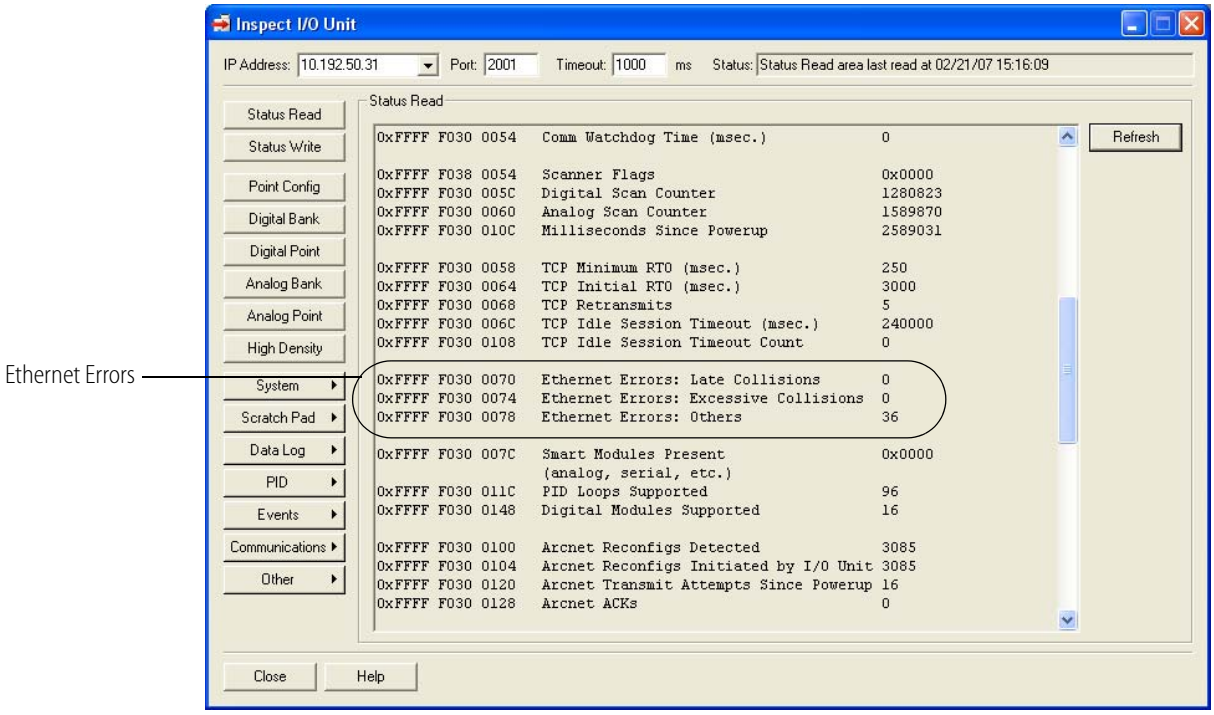
If there are recurring problems in communicating with the brain, check your network. The cables, routers, and so on in your Ethernet network are not part of the Opto 22 hardware, but any problems in your network may affect communication with Opto 22 products.

Create a Network Diagram—First, create a network diagram and verify the following:

- Cable connectors are firmly inserted.
- The Ethernet network switch has power. Switch LEDs indicate that the connection is up. If SNAP PAC brains are daisy-chained, LNK LEDs for both of their Ethernet interfaces are lit.
- Neither the PC nor the brain uses the switch's uplink port.
- The brain's LNK LED(s) are lit.

Check Ethernet Errors—Next, use PAC Manager to check Ethernet errors reported by the brain. These errors indicate network problems. You will need to know the brain's IP address.

1. Choose Start➞Programs➞Opto 22➞PAC Project Software➞PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the brain. Click Status Read.
4. Scroll down until you see the items Ethernet Errors: Late Collisions, Ethernet Errors: Excessive Collisions, and Ethernet Errors: Others.


Ethernet Errors
Inspect I/O Unit
IP Address: 10.192.50.31
Port: 2001
Timeout: 1000 ms
Status: Status Read area last read at 02/21/07 15:16:09
Status Read
Status Write
Point Config
Digital Bank
Digital Point
Analog Bank
Analog Point
High Density
System
Scratch Pad
Data Log
PID
Events
Communications
Other
Refresh
0xFFFF F030 0054 Comm Watchdog Time (msec.) 0
0xFFFF F038 0054 Scanner Flags 0x0000
0xFFFF F030 005C Digital Scan Counter 1280823
0xFFFF F030 0060 Analog Scan Counter 1589870
0xFFFF F030 010C Milliseconds Since Powerup 2589031
0xFFFF F030 0058 TCP Minimum RTO (msec.) 250
0xFFFF F030 0064 TCP Initial RTO (msec.) 3000
0xFFFF F030 0068 TCP Retransmits 5
0xFFFF F030 006C TCP Idle Session Timeout (msec.) 240000
0xFFFF F030 0108 TCP Idle Session Timeout Count 0
0xFFFF F030 0070 Ethernet Errors: Late Collisions 0
0xFFFF F030 0074 Ethernet Errors: Excessive Collisions 0
0xFFFF F030 0078 Ethernet Errors: Others 36
0xFFFF F030 007C Smart Modules Present 0x0000
(analog, serial, etc.)
0xFFFF F030 011C PID Loops Supported 96
0xFFFF F030 0148 Digital Modules Supported 16
0xFFFF F030 0100 Arcnet Reconfigs Detected 3085
0xFFFF F030 0104 Arcnet Reconfigs Initiated by I/O Unit 3085
0xFFFF F030 0120 Arcnet Transmit Attempts Since Powerup 16
0xFFFF F030 0128 Arcnet ACKs 0
Close
Help

All three of these items should have a value of zero. If any of these items has a value other than zero, you may have a network problem.

Analyze Communication Packets—If it appears that you have network problems, you can use a utility program such as WireShark (www.wireshark.org) to log and analyze network communication packets.

Have Your Network Certified—If you suspect network problems, you may need to have your network professionally certified. Opto 22 does not offer network validation or certification services, but many network hardware manufacturers do. Contact the manufacturer of your Ethernet network hardware to have them diagnose, fix, and certify your network.

If you continue to have problems communicating with the SNAP PAC brain after your network is certified, contact Opto 22 Product Support. (See page 4.)

Additional Troubleshooting Tools

Making Sure the Brain is in Normal Mode

If you are having trouble communicating with the brain, it might be in *fail-safe bootloader mode*. This is a diagnostic mode that you don't need to access unless you are troubleshooting a problem with Opto 22 Product Support. The brain restarts in fail-safe bootloader mode when you hold down the RESET button longer than the time needed to restore the default settings. If your brain restarts in fail-safe bootloader mode, simply cycle power to the device. This action performs a simple restart and allows you to communicate with the brain. For more information on using the RESET button, see "Resetting the Brain" on page 22.

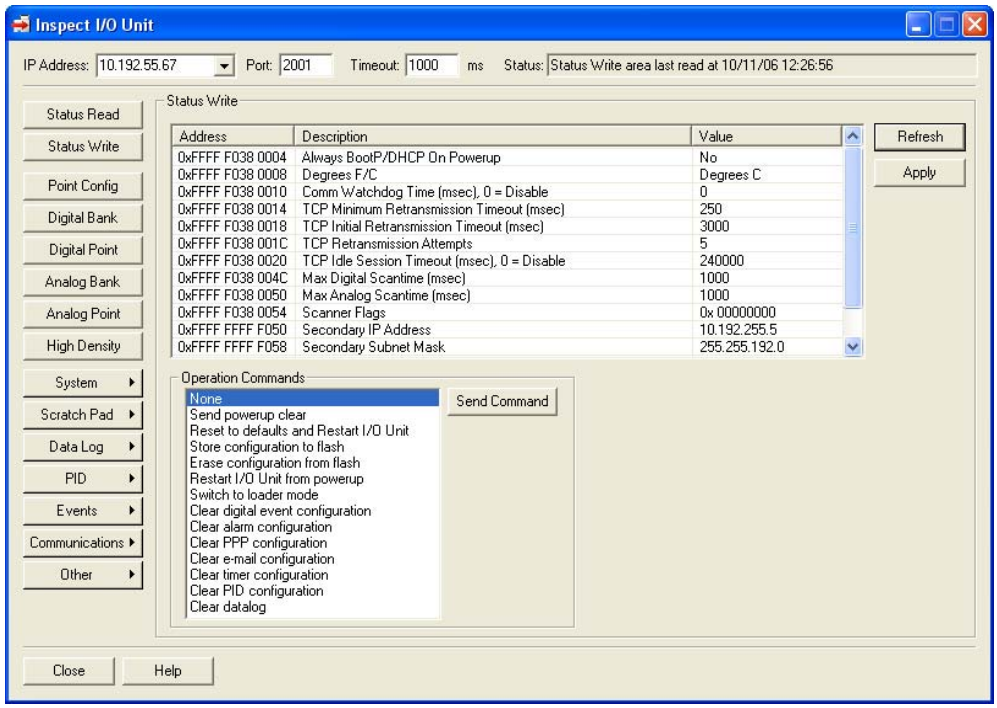
TCP Settings

Retransmit timeout (RTO) refers to the length of time the brain waits while communicating before timing out. The RTO is determined by the brain's TCP/IP stack, and the stack continually recalculates the RTO based on recent network traffic. If the network becomes busier, for example, the stack automatically adjusts the RTO to a higher value.

If the TCP/IP stack times out while trying to transmit data, it doubles the current RTO and tries again. This process continues for five retries; after that, the brain stops trying and sends a timeout message.

If you are receiving frequent timeout messages from the brain, you can change the TCP parameters in PAC Manager.

1. Choose Start→Programs→Opto 22→PAC Project Software→PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the brain. Click Status Write.



CAUTION: *Note the following recommended settings:*

TCP Minimum Retransmission Timeout (msec):	*250*
TCP Initial Retransmission Timeout (msec):	*3000*
TCP Retransmission Attempts:	*5*
TCP Idle Session Timeout (msec):	*240,000*

If you set these fields too low, you may not be able to communicate with the device at all, even through PAC Manager, to fix the settings. Then you would have to reset the brain to factory defaults (see page 22).

4. Change these four fields as necessary:

Minimum RTO sets an absolute minimum value for the RTO. The device's calculated RTO will never go below this value.

Initial RTO sets the RTO for the first communication try. Be careful: since all future tries are based on this value, if you set it too low for network conditions, a connection will never be made.

TCP Retransmits sets the number of times the device retries communication. Larger, busier networks need a higher number of retransmits than smaller networks with less traffic.

TCP idle session timeout sets how long (in milliseconds) the device allows a session to remain open without any activity. After this time, the device checks the session to make sure it is still good, and closes it if it is not. The default is 240,000 milliseconds, or four minutes.

5. Click the Apply button to write your changes to the brain.
6. In the Operation Commands list, highlight Store configuration to flash. Click Send Command.
7. In the Operation Commands list, highlight Restart brain from powerup. Click Send Command.

   The new TCP parameters are set.

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